IEA/SolarPACES

Task I: Electric Power Systems

Task Meeting Summary:

Köln, Germany **20 June 2001**

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November 5, 2001

IEA/SolarPACES Task I Participants:

Since the last task meeting summaries published early this year, we held an IEA/SolarPACES Task I: Electric Power Systems task meeting at the DLR offices in Köln, Germany, on 20 June 2001. Please find enclosed my summary of the meeting. The table below provides a snapshot of Task I at this time, including the new Sector 3: CSP Market Development (combining the old Sectors 3 and 4). Thanks for your active participation in Task I activities and for helping expand our areas of cooperation.

Task I: Electric Power Systems (C. E. Tyner, Operating Agent)

Sector 1. Central Generation Systems (Manuel Romero, Sector Leader)

- DIrect Solar Steam (DISS)
- THESEUS Project
- EuroTrough
- USA Trough
- Solar Two Final Evaluation/Solar Tres
- 10-MW Solar Thermal Power Plant for Southern Spain (PS10)
- Solar Gas Turbine with Tower Reflector
- Hybrid Power Plant Assessment/TIPP
- SolGate

Sector 2. Distributed Generation Systems (Wolfgang Meike, Sector Leader)

- EuroDish
- SAIC USJV Project
- Dish Engine Critical Components Projects
- Remote Dish System Development
- Reliability Database

Sector 3. CSP Market Development (Tom Mancini, Sector Leader)

- START Missions
- Developing Projects – India, Egypt, Morocco, Mexico, Brazil, Spain, South Africa
- Identification and Evaluation of Market Barriers
- Database of Project and Market Opportunities
- Technology Roadmapping
- STEPS - Expert System for Solar Thermal Power Stations
- SolWin/RENIP Plan

Sincerely,

Craig E. Tyner
Operating Agent, Task I

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Task I Meeting Summary

Köln, Germany **20 June 2001**

(in conjunction with Task II and III meetings and DLR's 5th Cologne Solar Symposium)

IEA/SolarPACES Task I Distribution List

IEA/SolarPACES Task I Meeting:
Electric Power Systems

20 June 2001
DLR, Köln, Germany

Meeting Summary

About 40 participants from 11 countries attended the Task I meeting, which was held in conjunction with Task II and III meetings, as well as DLR's 5th Cologne Solar Symposium. Sector 3 discussions included GEF-supported and other commercial project status, as well as options for future START activities. Sector 1 discussions covered volumetric receiver and advanced trough system testing, as well as project opportunities in Spain and elsewhere. Sector 2 discussions included updates on the status of dish/Stirling testing and project opportunities in the U. S. and Europe.

Meeting Details

Craig Tyner opened the meeting as Task I Operating Agent. He first discussed the new Sector 3: CSP Market Development (replacing the sectors on START and Market Barriers and Opportunities), as well as the new Task I brochure, "Concentrating Solar Power in 2001". (A Task II meeting chaired by Aldo Steinfeld was held in parallel.)

Tom Mancini led **Sector 3** discussions. **Amina El-Zalabany** of NREA summarized the Egyptian GEF project, where the RFP is expected to be out within 6 months, and **Ayman Fayek** presented a brief discussion centered on obtaining glass samples for testing at the site in Egypt.

Michael Geyer gave an update on the other GEF activities. The Moroccan GEF project Ain Beni Mathar will utilize some of the gas Morocco gets from the large pipeline to Spain, and underground water is available. A new radiation monitoring station is operational, and sees about 5-10% more insolation than the corresponding amount in Spain (2200-2300 kWh/m²y by preliminary estimates). The GEF grant is about $44M, to be committed by 2003. Fichtner and DLR are under contract to prepare the RFP, with a pre-RFP conference this fall (RFP by end of year). Plant size is now about 250MW (limited by cooling water availability). Morocco has deregulation underway which is expected to be fully in place by the time the plant is operational (2004-5), so the PPA will probably be for solar energy only, with gas on a merchant basis.

In India, the site is Mathania (in the state of Rajasthan), with radiation about 2300kWh/m²y. The 130 MW plant will be fired by naphtha. 3 consortia have prequalified, and an RFP document has been finished. RSPCL is now finalizing the PPA. Recent fuel price increases have caused current prices to be about 10¢/kWh (on 2000MW Enron plant); thus there are no new PPAs for naphtha plants. They are considering now a shift to natural gas. The plant can't be solar only because the permitting process would have to start over.

In Mexico, a plant is planned at Cerro Prieto (near California border, and power could be sold to California). The solar plant could be as large as 40MW peak. CFE is preparing the RFP, scheduled for completion by October, with a contract by October 2002. The RFP will not be for solar, but for a GTCC, with solar being considered if appropriate, utilizing the GEF grant.

Jorge Lima, CEPEL, discussed the status of the Brazilian GEF activity. The project is to reduce the long-term cost of solar thermal in Brazil. The project will run 14 months, with $334k GEF grant plus $50k from CEPEL. MME oversees the project. Objectives are identifying the most promising technologies, market size assessment, feasibility study for initial plant, and promoting national and international seminars to spread the results. The NE region of Brazil has over 6kWh/m²d. Overall project length is about 6-8 months.

Manuel Romero discussed the situation in Spain. The current premium is 12euro ¢/kWh (20 pts/kWh). PS10 total cost is about 29.4M euro, with a go/no go decision expected in November. Permitting is again underway, with results expected in October. Bank loans are being renegotiated (subject to the new premium rate). Manuel also gave a brief summary of Solar Tres, including potential involvement of Sener (the Spanish engineering company). European participants (for the requested EU grant) include Saint Gobain (French glass company) and CIEMAT; they are also awaiting word on Spanish national grants.

LucaSol is a 30-50 MW parabolic trough plant, based on SEGS experience and EuroTrough (with thermal storage). Cost is expected to be 130M euro for a 50 MW plant (2600 euro/kW). A final decision will depend on the final premium (50 MW with large storage if premium is 20 pts/kWh).

E. Guelbenzu presented the EHN Solar Park concept, Montes Del Cierzo (near Pamplona). EHN group is 37% Iberdrola, 20% a society of local governments, plus a local savings bank and cement company. They produce 30% of Spain's (and 5% of world's) wind, and have now signed the biggest wind power contract in the world (1800 700kW turbines). They have initiatives in 22 countries, including biomass and mini-hydro. All solar technologies will be represented. The park will be 21.5MW, including PV (1.2MW already under construction) and tower with storage, troughs, and Dish Stirling. For solar thermal, they are looking for 1 power block with 2 fields (10 MW SEGS or EuroTrough troughs and 5 MW of tower with a solar multiple of two (10MW equivalent) and 5 hr storage). The trough project will start in 2002. The tower will start in 2003. They also plan a 120kW dish/Stirling plant with dishes from several providers. The long-term plan is solar plants worldwide.

Wes Stein described the Australian situation, including the new RE requirement for about 3GW by 2010 (with certificates to verify compliance); the penalty is A$40/MWh above the pool price (A$30/MWh). This is enough for some wind, large biomass, but not solar. (Biomass eligibility is still under discussion as to whether it is green or not.) He expects distributed generation (less than 40MW each), rather than large projects.

Craig Tyner then discussed the U. S. situation, including current budget prognosis and Congressional situation, as well as the new activity in Nevada. The budget perspective now looks better than in recent months, with there being a reasonable expectation of level funding for fiscal year 2002. There is Congressional support for installation and operation of a new 1MW dish/Stirling facility in southern Nevada. Depending on funding, installation could start in late FY02. Two demonstration systems will be installed this summer.

Rainer Kistner discussed software development at DLR. SolWin (solar thermal) was expanded to RENIP plan as a simulation tool for RE systems. This has been enhanced to a professional and user-friendly tool for RE systems (greenius). Requirements include integration of technical and economic considerations. Greenius currently includes wind, PV, trough (with and without storage) and dish/Stirling. The code has been validated against the SEGS plants. He then ran a demo of the program for hypothetical Cologne and Almeria sites and parabolic trough and PV plants. The overall operation appeared to be very useful.

Tom Mancini discussed the status of the SolarPACES project database, describing the system and encouraging updates to keep the system current. He also discussed the option of a supplier database, but

there was limited interest. Tom decided to review the status of available solar thermal manufacturers lists and make a recommendation at the next task meeting.

Regarding the organization of the new Sector 3, Tom described the reasons for consolidation of the old Sectors 3 and 4, including the limited need for future START missions. Options include missions to governments to address barriers; focus on sustainability; and working more closely with WB, GEF, etc. Other thoughts included: Pitz-Paal: Market barriers are very country-specific issues, but we could provide input to individual countries, but being careful not to infringe on individual country issues. Geyer: opportunities for training/experience at existing facilities and plants (although we don't have budget). Fayek: follow-on technical support on a regular basis (opportunity for discussion of issues as they arise). Geyer: expert technical advisory board to review issues, plans, details, etc. Kribus: need pool of experts. Stein: government START mission (very high level; Becker: limit to technical role). Tom will put together a team to craft this technical support activity and report back. Potential team members include Kribus, Stein, Pitz-Paal, Romero, and Geyer.

Manuel Romero led discussions in **Sector 1**, Central Generation Systems. The only report on the Israeli beam down activity (from Kribus) is that testing is continuing. **Reiner Buck** reported on volumetric receiver development as part of methane reforming testing at WIS. In conjunction with REFOS, SolGate is designed to test 3 receiver modules integrated with a turbine to demonstrate a full system. Israel, Spain, and Switzerland are all partners with DLR. Hardware development is underway, with installation in January of next year. Test time is 8 months (to end in fall 2002). There will then be a detailed conceptual commercial system layout by 2003.

Eckhard Luepfert discussed the EuroTrough project achievements. The first trough has been installed for thermal testing at the PSA. Detailed characteristics were presented, with an expected cost of <200euro/m². New features include a torque box (base on wind tunnel test data); a very limited number of different structural elements; and jig assembly (limiting adjustments needed to the jig, not each assembly). Cost reductions identified include improved optical performance; simplification of design; weight reduction; extension of collector length; and ability to conform to up to a 3% slope. Stow is required at wind speeds of 40m/s. Thermal testing is just completed and seems to indicate performance is as good as expected. The next step will be annual performance modeling for commercial applications. Plans for the next level of testing (by the German partners at least) include a full loop (new) of testing at KJC, with detailed plans expected by September.

Klaus Hennecke described the DISS project. Phase I built the 500m loop of LS-3 type collectors. Phase II has included extensive testing. Problems included temperature measurement; the DAS system (because of high data rate); and water recirculation pump failure (because of limited pressure capability). O&M experience included the large thermal inertia of startup; open loop tracking errors; ball joints working well; and improved thermal and piping layout. Main test results include pressure drop less than expected; good prediction of circumferential temperature distribution (and acceptable); adequate control system function. The project has included 2700 hours of operation, and temperatures up to 390C have been achieved. Facility capabilities are good, and steam generation in horizontal tubes is feasible. The next needs include identification of better steam separators and achieving temperatures up to 500C. **Markus Eck** followed with a discussion of the recirculation issues and the trade offs of eliminating the recirculation pumps (which is possible) against the cost of additional collectors to offset the efficiency losses caused by eliminating the pump. Overall, their current assessment is that DSG is still a viable option, with potential cost savings of 25% over oil systems.

Tom Mancini presented **Hank Price's** material on U. S. trough activities. Reliability of the new UVAC receiver glass-to-metal seals has been improved, as has performance by about 20% (overall understanding of this improvement is not fully understood). He also described the storage work for troughs, including the Nexant studies and the thermocline storage testing at Sandia. SunLab is also investigating organic salts as heat transfer fluids for future applications. He also described the Nexant study of impact of solar

fraction on over all system efficiency, predicting a drop in performance as solar fraction increases. He also described ORC applications for small trough systems (1-10MW). LECs are about 20c/kWh. For more information, see the TroughNet web site.

Michael Geyer summarized the status of THESEUS. Deregulation in Greece is affecting the uncertainty of the project, but a low fixed premium (90% of average price) has been eliminated. Current process is a bid process, making it more difficult. The site has changed from Frangocostello (too many landowners) to a new site in western Crete with fewer landowners. Application for a permit is being pursued again. Whether a cost-covering premium can be found in not yet known.

Wes Stein described the Australian activities, including a new floating linear fresnel system (it tracks by rotating azimuthally as it floats and moving the receiver) to generate steam at 500C, built by Yeomans (an industrial concern). Their target is $1000/kWe. The ANUTech Big Dish Showcase project has been terminated for commercial reasons. The Solar Systems dish designed for PV is also being tested at CSIRO for reforming, and Wes would like to see it tested with a Brayton engine. Orion Energy (from California) is developing a small ORC system that could be integrated with a trough system at 17% efficiency (which Wes was very skeptical of). The CLFR from Sydney University is still planned for a 13MW Showcase project, although none of the initial demonstration has yet been built.

Craig Tyner discussed the current Solar Tres design and status, using materials from **Alex Zavoico** of Nexant. The plant will be 15MW, with a solar multiple of about 3. The current heliostat concept is 96 m^2, and the power block has a number of innovations beyond Solar Two (long-shafted pumps (allowing elimination of sumps), SGS elevated in the tower, and significant simplification through elimination of valves, heat trace, etc.).

Manuel Romero discussed the PS10 update. The current site is near Seville, on Casa Quemada. Solar radiation has continued to be measured near the site (2 years), and additional data from the University of Seville correlates well. Overall, the resource exceeds 2000kWh/m^2y (still only fair). Heat storage size and configuration have been refined, and Al2O3 saddles will be used (to reduce costs relative to alumina balls), with a total capacity of 18MWht (0.5 hours, reduced from 1.5), enough to provide operating stability. Steam generator, power block, and master control system are ready for ordering once the go-ahead is given. The planned heliostat is the Sanlucar 90, while the most critical component is the receiver.

Tom Mancini substituted for **Wolfgang Meike** as **Sector 2** leader for Distributed Systems. **Peter Heller** updated the status of the EuroDish project, which is nearing conclusion. The system cost goals are 5500euro/kW installed, with tools for production of small quantities. Foundation accuracy was requested to be 3mm, which was only achieved with grinding after the pouring. Facets are 20mm foam with fiber-glass-reinforced sheet on the front and back; glass is glued to the front fiberglass. Surface precision is measured with a jig with several micrometers making mechanical measurements, and adjustments are made prior to the fiberglass edges of two facets being glued together with fiberglass tape and resin. The fully assembled dish is lifted and mounted to the support structures. The elevation drive has a second motor for emergencies (DC for battery use). The second unit has been installed (but is still awaiting the engine). The cost goal will be met (for a 10-unit build). A crane is needed for installation (otherwise only unskilled labor is required). Installation time is one-to-two weeks, depending on personnel available.

Tom Mancini talked about the remote dish system, including the progress from the first prototype (grid connected) to the second generation (stand-alone capable). For remote application, power management had to be redesigned for self-starting. Tom also described the Boeing/SES DECC system. Two of the original MDAC systems are currently running at the Boeing test site. New engine blocks for the next, redesigned systems are ready for assembly, as are many of the parts for the new dishes. The new control system design is behind schedule and likely will not be ready for initial testing (scheduled in early 2002). Tom also discussed the SAIC project status. 3 systems continue to operate near Phoenix, AZ, and one

system operates at NREL in Colorado. The Arizona systems have 4000 hours of operation, with hybrid operation of all systems demonstrated with either natural gas, hydrogen, or landfill gas.

Tom briefly discussed the reliability database, and data from the early systems. MTBF for major failures is now up to 50 hours or so for the U. S. system. Finally, he also described the Nevada dish project goals. The first two dishes (one from SAIC, one from SES) will be installed this summer for preliminary demonstration purposes. The plan is to have 40 dishes installed by 2003, depending on the availability of funding.

After conclusion of the Task I meeting, discussion went back to the discussion questions raised in the **small systems discussion** from the Task III meeting. Kribus characterized the situation into demand and supply side issues, perhaps to be discussed in a web format. Potential participants in a task force to investigate include Kribus, Mehos, Buck, Ramos, Schramek, and Hennecke. Objectives include defining systems, setting up classification, and identifying who would be interested in further participation. Feedback should be available for the next ExCo meeting. Kistner voiced the contrasting opinion of some that big is beautiful (economies of scale, O&M issues).

Next Meetings:

The next Task I meeting will be held in conjunction with a Task III meeting (subject to final confirmation of dates) in Madrid on Friday, March 15, 2002. The combined meetings will focus on Spanish issues. The following set of task meetings (all three tasks) will be held September 9-11, 2002, in conjunction with the 11th SolarPACES International Symposium on Concentrating Solar Power and Chemical Energy Technologies, in Zurich or Interlaken, Switzerland.

Action Items:

1. Tom Mancini: Coordinate team efforts to make recommendations on future directions of START missions and other Sector 3 activities.

Appendix A: Meeting Agenda

IEA/SolarPACES Task I: Electric Power Systems

Task Meeting

Cologne, Germany
Wednesday, June 20, 2001

Agenda

(adjusted Post-Meeting)

09:00	**Introduction and Opening Remarks (Craig Tyner, Operating Agent)**	
	• Task I Issues/Updates	Tyner
	• New Sector 3: CSP Market Development (combines functions of previous Sectors 3: START Missions and 4: Market Barriers/Opportunities. Tom Mancini is the Sector Leader.	Tyner, Mancini, Geyer
	• Updated SolarPACES Position Paper	Tyner
09:15	**SECTOR 3: CSP Market Development (Tom Mancini)**	
	• GEF Projects Status: Egypt, India, Morocco, Mexico, Brazil	Geyer, Lima
	• European Projects Status: Germany, Greece, EU	Geyer, Other?
	• Current projects status and market opportunities in Spain	Romero
	• Initiative for a Solar Park in Navarra, Spain	E. Guelbenzu (EHN)
	• Other Projects Status: Australia, US	Stein, Tyner
	• Project and Market Opportunity Database	Mancini
	• RENIP Plan	Kistner
	• START Mission options and/or redirection	Mancini
	• Market Development Opportunities Discussion	All
12:00	LUNCH	
13:30	**SECTOR 1: Central Generation Systems (Manuel Romero)**	
	• Solar Gas Turbine and Tower Reflector	Kribus
	• SOLGATE Project	Buck
	• Hybrid Plant Assessments / TIPP	Geyer
	• EuroTrough	Luepfert
	• DISS Update	Hennecke
	• DSG/DISS	Eck
	• US Trough Development Activities	Mancini for Price
	• THESEUS	Geyer
	• Australian Activities	Stein
	• Solar Tres Update	Tyner for Pacheco
	• PS10 Update	Romero
15:00	BREAK	
15:30	**SECTOR 2: Distributed Generation Systems (Mancini For Wolfgang Meike)**	
	• SAIC/USJVP and Boeing/SES/DECC 25 kW Systems	Mancini
	• 10-kW Remote Power System	Tyner for Diver
	• EuroDish	Heller
	• Reliability Database	Mancini for Mehos
17:00	Action Items, Adjourn	

Appendix B: Meeting Participants

SolarPACES Task I Meeting, Cologne, 6/20/2001

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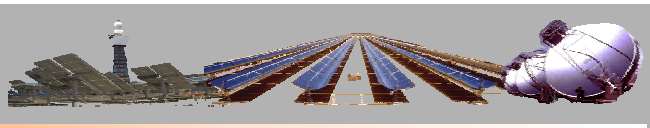
Appendix C: Presentation Summaries



Update on the Progress of the CSP Projects with GEF Support

Task III Meeting, June 20th 2001 at DLR Cologne

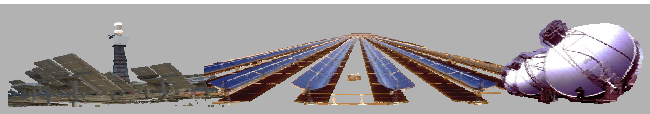
Dr. Michael Geyer

IEA SolarPACES Executive Secretary

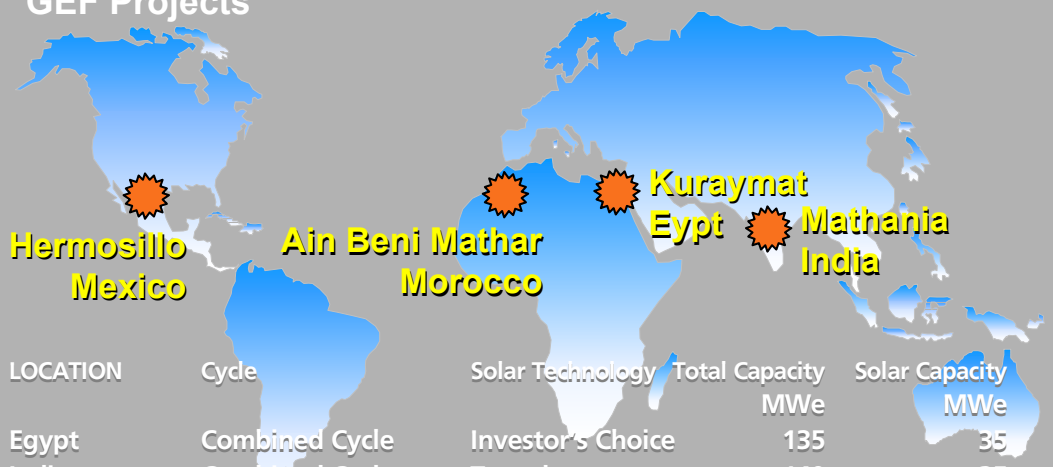
SolarPACES

Solar Power And Chemical Energy Systems

1



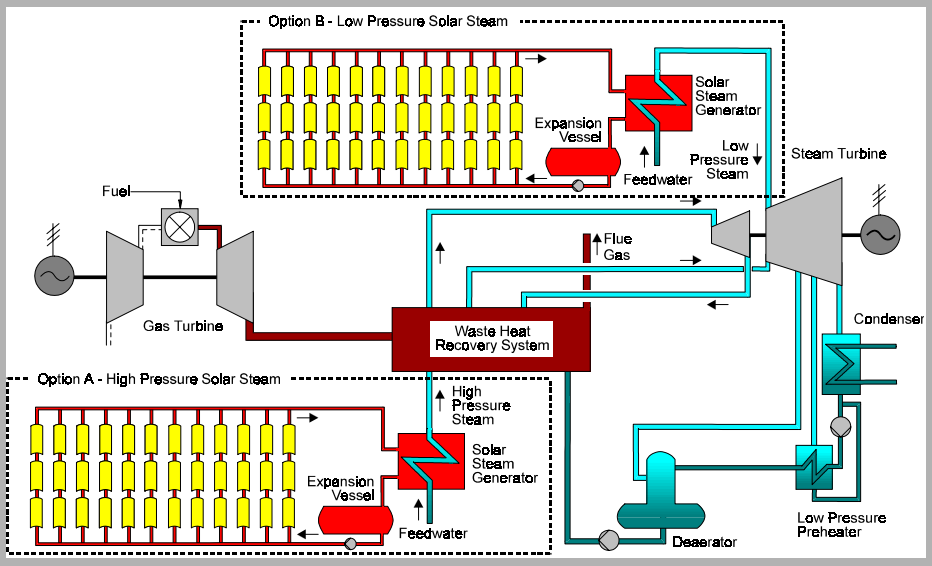
GEF Projects



LOCATION	Cycle	Solar Technology	Total Capacity MWe	Solar Capacity MWe
Egypt	Combined Cycle	Investor's Choice	135	35
India	Combined Cycle	Trough	140	35
Iran	Combined Cycle	Trough	398	67
Mexico	Combined Cycle	Investor's Choice	312	40
Morocco	Combined Cycle	Investor's Choice	150	30-50

2

The GEF Project at Kuraymat (Egypt)



3

The GEF Project Ain Beni Mathar (Morocco)

3. COSTS AND FINANCING (MILLION US):

GEF:	-Project	US$ 43.20 million
	- PDF:	US$ 00.70 million
	Subtotal GEF:	**US$ 43.90 million**
CO-FINANCING:	-IA:	US$ 00.35 million
	-Other International:	US$ 00.53 million
	-Government of Morocco:	US$ 00.18 million
	-Private	US$ 69.40 million
	Subtotal Co-Financing:	**US$ 70.46 million**
TOTAL PROJECT COST:		**US$114.36 million**

4

The GEF Project Mathania (India)

5

The GEF Project Mexico

ISCCS PROJECT IN MEXICO
Construction Schedule

CFE has programmed 4 CCGT power plants for Baja california Electrical Grid with the following Start Up Schedule:

- Baja California I, 260 MW 2005
- Baja California II,260 MW 2007
- Baja California III,260 MW 2008
- Baja California IV,260 MW 2009

The ISCCS could be implemented under the Baja California I Power Plant,with the following preliminary construction program:

Evaluation and approval by CFE	June 2001
Grant approval by GEF	June 2001
Specifications	August 2001
International Request for Proposals	October 2001
Contract Assignment	October 2002
Construcción Start Up	February 2003
Commercial Operation	April 2005

6

Reducing the Long-term Cost of Solar Thermal Power Generation

Cologne, Germany - Jun 2001

"PDF - BRA/98/G41/A/99"

Presented by JORGE LIMA
Prepared by E. S. CAMÊLO CAVALCANTI

History

JAN/97	PDF Project Proposal Directed to UNDP.
	UNDP Submits PDF Project to GEF.
JUN/97	GEF Indicates PDF for New Scientific Fundings
DEC/97	STAP Recommends GEF to Finance New PDF Project.
MAR/98	GEF Approves the Financing to PDF Project
APR/98	UNDP Submits to CEPEL Final Version of PDF Project
APR/98	CEPEL Sends PDF Project to SEAIN/MOG
DEC/98	CEPEL Informs UNDP Implementation Agreement of PDF Project
JUN/99	GEF Approval for PDF Project Implementation

PDF Project

PRE-COMMERCIAL PLANT	BRAZIL
PERIOD	14 MONTHS
EXECUTING AGENCY	MME
GEF FINANCING	US$ 334.750
CO-FINANCING (CEPEL)	US$ 50.000
SEMINARS	FOUR

Objectives

Identify the most promising technologies to be integrated into the Brazilian electric system;

Market size assessment;

Feasibility study for initial plant using technical, economic, environment and social analysis;

Promote national and international seminars to evaluate PDF Project;

Objectives

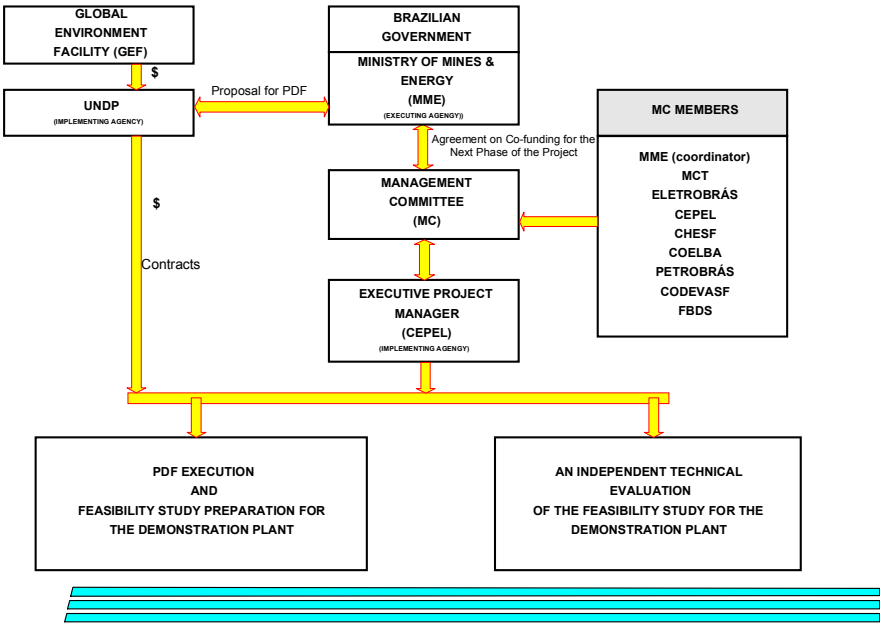
Formulate a full-scale proposal to determine the pre-investment requirements for demonstration of the selected technology at a commercial scale including the incremental cost analysis;

Identify and mobilize co-funding for the full-scale pre-investment project;

Establish a cooperation protocol with the participants for Phase II of the Project;

Establish independent technical evaluation of the project.

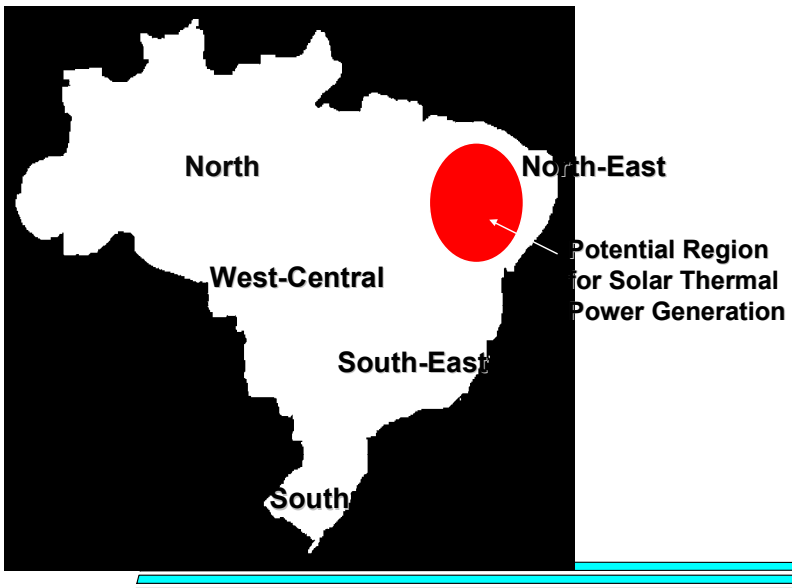
Organization



Budget

DISBURSEMENT	GEF US$	Co-funding US$
1. International experts (including travel) for:		
- market analysis	30,000	
- technology design, O&M workshops and courses	40,000	
- technical/economic/environmental/social feasibility study	45,000	
- identification of barriers and a barrier removal strategy	15,000	
- Block Design of the Selected Technology	60,000	
- final technical evaluation	10,000	
2. Travel		
- Local	15,000	
- International Travel of Experts to Brazil	20,000	
3. Local Experts (cooperating with international experts)		50,000
4. Workshops (national)	20,000	
Workshops (international)	60,000	
5. Miscellaneous	10,000	
Subtotal	325,000	
Project Support Services (3%)	9,750	
TOTAL	334,750	50,000

Potential Area



Work plan

Phase I (5 months)

Technologies interaction (CSP) with the electric system.

Market identification for CSP.

Identification of manufacturers capability, O&M for CSP.

Perform CSP Courses.

National Seminar.

Proposed Schedule Phase I

PRINCIPAL TASKS	TIME (months) 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Concentrating Solar Power Technologies (CSP) and Storage/Back-up Unit Reviewed with Respect to the Expected Load Characteristics Weather Patterns and Interactions with the Brazilian Power System														
2. Analyses of CSP Long Term Cost Reduction Potential and Competitiveness with Other Options, and Environmental and Social Aspects														
3. Contact Other Countries for Potential Participation in This PDF for Concentrated Solar Power Technologies Production														
4. Identify Local Capacities to Operate, Maintain, and Manufacture Different CSP Technologies														
5. Evaluation of the Expected Size of the Brazilian Market for CSP Technologies														
6. Need and Availability of Financial Resources to Invest in CSP Production in Large Scale to Result in the Expected Cost Reductions														
7. Workshops and Courses Related to Potential CSP Technology for the Demonstration Plant														
8. Identification of Risks to the CSP Technology and Its Commercialization														
9. Organization of the Three Days International Workshop on CSP Technologies Closing Phase 1														
10. Realization of the Three Days International Workshop on CSP Technologies Closing Phase 1														

Work plan

Phase II (3 months)

Select CSP for the Pre-commercial Plant.

Definition of Pre-commercial Plant basic parameters.

Costs reduction proposal for CSP.

National Seminar.

Proposed Schedule Phase II

PRINCIPAL TASKS	TIME (months)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
11. Based on Tasks 1-8, Select CSP Technology, for Demonstration, Most Likely to be Successful, Based on Scientific and Technical Considerations, O&M Requirements, Prospects for Sustainability and Replicability, Incl. Cost Reduction Aspects to bring CSP in Commercial Acceptability														
12. Set Out Programmatic Cost Reduction Objectives, Estimate Finance Requirements and Time Needed to Reach the Targeted Cost Reduction, And Identify the Capacity Building and Targeted Research Needs to Support Investments in CSP Power Production														
13. Formulate a Draft Strategy to Achieve the Cost Reduction Objectives And Increase the Market Share of CSP Power Production														
14. Definition of the Basic Design Parameters of the Pilot Plant														
15. Organization of the Three Days International Workshop on CSP Technologies Closing Phase 2														
16. Realization of the Three Days International Workshop on CSP Technologies Closing Phase 2														

Work plan

Phase III (6 months)

Identify needs of R&D.

Promote institutional capability for technology transfer.

System sizing - define system Power.

Long-term planning to use CSP.

National Seminar.

Proposed Schedule Phase III

PRINCIPAL TASKS	TIME (months)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
17. Undertake Technical, Economic, Environmental and Social Feasibility Studies for the Pilot Plant														
18. Detailed Block Description of the Demonstration Power Plant Based in the Chosen Technology														
19. Identify and Develop Plans for Involvement of All Relevant Stakeholders and Manufacturers in Regard to the Selected Demo Project														
20. Identify Capacity Building Requirements to the Technology to be Demonstrated to Ensure Adequate Institutional Capacity for R&D, Technology Transfer, and Long-Term Planning Related to CSP Power Production														
21. Organization of the Three Days National Workshop on CSP Closing Phase 3														
22. Realization of the Three Days National Workshop on CSP Closing Phase 3														

Work plan

Phase IV (13 months)

Identify co-investors.

Celebrate Cooperation Protocol for Phase II.

Prepare pre-project proposal of the pre-commercial Plant.

Independent report for the Project.

International Workshop.

Proposed Schedule Phase IV

PRINCIPAL TASKS	TIME (months)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
23. Based on Tasks 11-14, Formulate a Full-Scale Proposal to Determine the Pre-Investment Needs for The Demonstration of the Selected Technology at a Commercial Scale Including the Incremental Cost Analysis														
24. Identify and Mobilize Co-funding for the Full-Scale Pre-investment Project														
25. Undertake Independent Technical Evaluations of the Project Identifying Potential Risks That Can Prevent Meeting Its Objectives and Suggesting Changes that Should be Made to Help it Meet Those Objectives														
26. Elaborate a Plan for Monitoring and Evaluation the Programmatic Benefits of the Project to Both the Development of the Technology and the Entire Electrical Grid														
27. Organization of the One Week International Workshop on CSP Technologies Closing Phase 4														
28. Realization of the One Week International Workshop on CSP Technologies Closing Phase 4														

Expected Results

Assessments of market size, financial requirements and time horizons needed to reach targeted cost reduction and market development objectives (planned for the end of the 5th month);

General frameworks and strategies to reduce the long-term costs, and to develop the market for solar thermal power production in Brazil and other participating countries; (planned for the end of the 8th month);

Feasibility study for an initial plant using the selected CSP technology incorporating detailed technical, economic, environmental and social analysis (planned for the end of the 12th month);

Expected Results

Plans for involvement of all key stakeholders (planned for the end of the 12th month);

Financing plans and agreements on co-funding for the full-scale pre-investment project, and an initial analysis of the resources needed and/or available for the subsequent investment (planned for the end of the 13th month);

Capacity building requirements to enhance participating countries' institutional capacity for research and development, technology transfer, and long-range planning related to solar thermal power generation for future larger applications (planned for the end of the 9th month);

Expected Results

Independent technical reviews of the project (planned for the half of the 13th month);

Detailed incremental cost analysis for the pilot plant following the Global Environmental Facility - GEF guidelines (planned for the end of the 14th month);

A plan for monitoring and evaluating the programmatic benefits of the project to both the developments of the technology and the entire electrical grid (planned for the end of the 14th month).

IEA SolarPACES Task I Experts Meeting
Cologne, 20 June 2001

SECTOR 3: CSP Market Development

Status of Solar Thermal Power Plant Projects in Spain

Manuel Romero
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Legal framework in Spain
(updated information as of June 2001)

In December 2000 the Spanish Parliament approved a proposal presented by the Government.

- Amendment to the Law 54/1997, of November 27, 1997 on the Electricity Sector.
- This amendment allows the Government to establish specific incentives for electricity produced by STPP.
- Previous to this amendment STPP were classified in the same category group than other ER like geothermal, tidal and waves:
  - Geothermal premium: 3.3 cents Euro/kWh
  - PV large plants premium: 18 cents Euro/kWh

IEA SolarPACES Task I Meeting
Cologne, Germany, 20 June 2001

Legal framework in Spain
(updated information as of June 2001)

The Ministry of Economy through its General Directorate for Energy and Mining Policy is the responsible of establishing adequate premium for STPP:

- Since January consultations to IDAE, CIEMAT and involved industrial consortia.
- A premium of 12 cents of Euro/kWh has been confirmed by the Ministry of Economy for STPP with unitary size < 50 MW.
- The new premium will be published within a R.D. establishing measures for improving market competition in the electrical sector. Text ready. Some difficulties with regulation for co-generation plants is delaying the publication.

Legal framework in Spain
(updated information as of June 2001)

- According to the "Plan for the Promotion of Renewable Energies in Spain", officially approved on December 30, 1999, the objective for Spain is to install at least 200 MW capacity of CSP systems by the year 2010, with a total electric energy contribution of 413 GWh.
- CSP projects may apply for R&D funds and 0% credits to the national PROFIT Calls.
- 28 million Euro in tax deductions.

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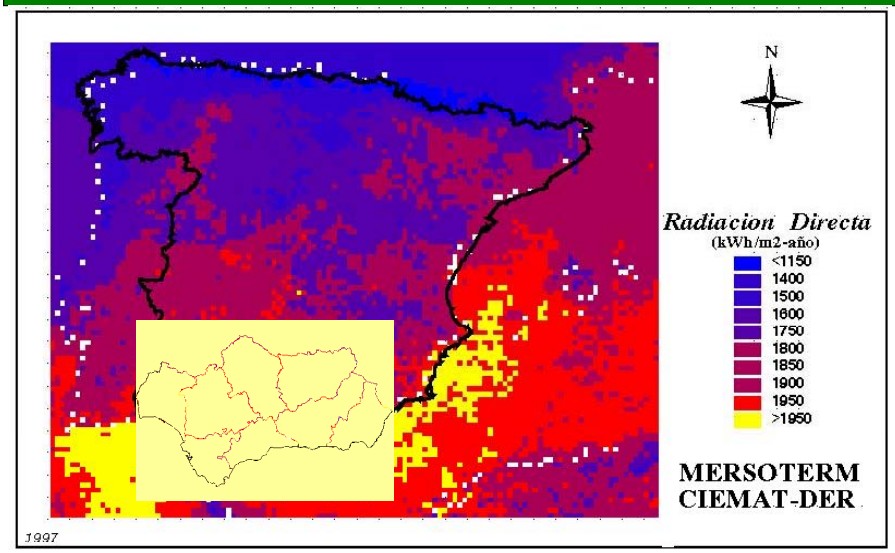
STPP initiatives for Spain
(updated information as of June 2001)

DNI distribution in Spain

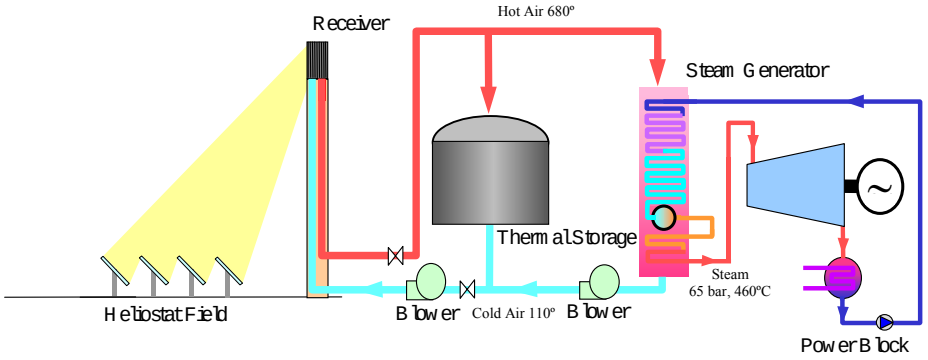


STPP initiatives for Spain
(updated information as of June 2001)

Name of plant	PS10	SOLAR TRES	LucaSol	Montes del Cierzo
Concentration Technology	Tower	Tower	Trough	Trough/Tower
Technology Basis	Phoebus (Volumetric Air Receiver)	Solar Two (Molten Salt Receiver/Storage)	SEGS (Eurotrough Collector)	Trough - SEGS Tower -Molten Salt?
Nominal power	10 MW	15 MW	30-50 MW	10 MW trough / 5 MW tower
Solar Multiple	1.12	3.8	1,2	1.0 trough / 2.0 tower
Potential site	Sevilla	Córdoba?	Almería	Tudela (Navarra)
Promoters/ partners	ABENGOA/IDAE	GHERSA, NEXANT, SENER?	GAMESA/Iberdrola Solar Millennium AG	EHN
Status as of June 2001	• Basic engineering project completed. • Environmental impact study in October. • Civil works starting in November.	• Project defined. • Application to EC funds. • Consortium being extended • Site selection not definitive.	• Consortium LUCAINENA SA created. • Sites identified • Basic engineering completed. • Financial engineering not ready.	• Project under definition • Feasibility study by December 2001. • Site already selected.

PS10 PROJECT

PS10 is a 10 MW solar-only CRS PHOEBUS-type demonstration plant producing electricity in grid-connected mode.



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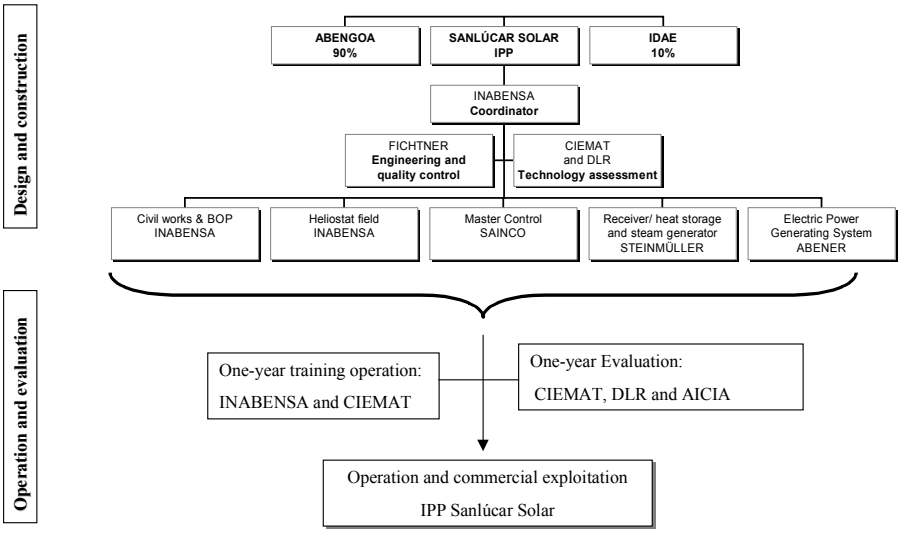
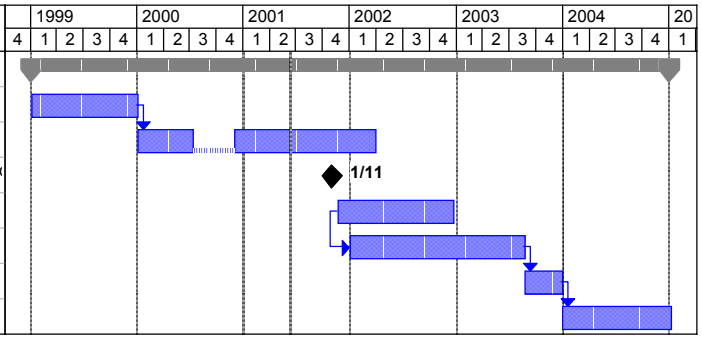
PS10 Organizational Chart



PS10: Review of project planning

Id	Nombre de tarea
0	**CHRONOGRAM PS10**
1	1 BASIC ENGINEERING
2	2 DETAILED ENGINEERING
3	Permits and environmental study cleare
4	3 MANUFACTURING COMPONENTS
5	4 SHIPMENT AND ASSEMBLING
6	5 ACCEPTANCE TESTS
7	6 OPERATION AND EVALUATION



Total budget: 29.4 million Euro (2,940 Euro/kW)

Solar Multiple = 1.12

PS10 status

☺The "Sanlúcar Solar S.A." PS10 IPP Consortium has been formed by ABENGOA (90%) and IDAE (10%).

☺Information about project status has been sent to the EC to apply for time schedule update approval.

☺Permits and environmental impact study should be ready by October 2001.

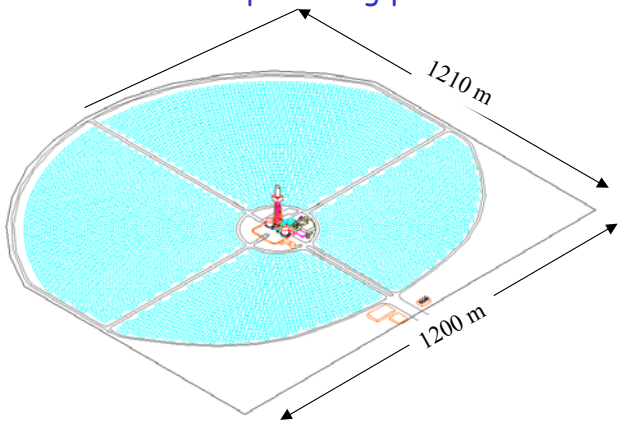
☺Civil works starting by November 2001 provided premium is eventually published (Milestone).

☺Bank loans are being re-negotiated for new premium expected of 12 EURO cents/kWh.

SOLAR TRES PROJECT

Design, construction and commercial operation of a 15-MWe "solar-only" power plant to be built in southern Spain using proven SOLAR TWO technology

- 15-MW power output (gross)
- 84 GWh annual production (gross)
- 40 MW_t steam generator
- 120-MWt cylindrical receiver (8.4x10.5 m)
- 263,600 m^2 heliostat field
- 115 m tower
- 16-hour storage (6,250 salt tons)
- 3.8 solar multiple
- 63% annual capacity factor
- 24 hours/day solar-only power production



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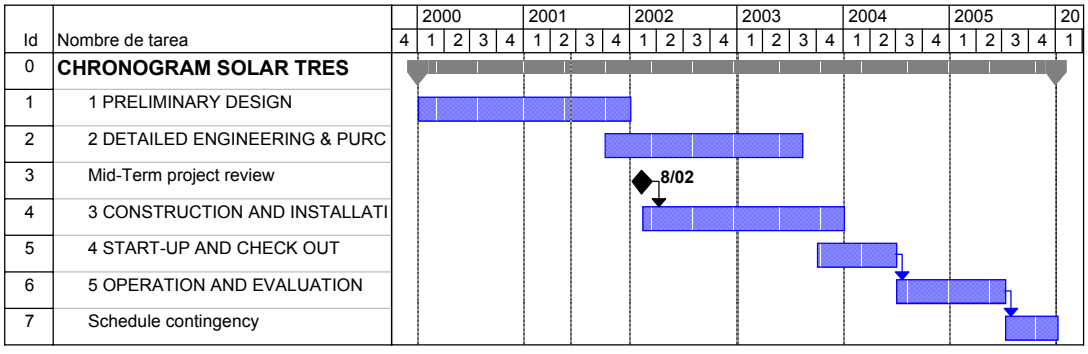
SOLAR TRES Status

- SOLAR TRES is a joint USA-Spanish project. The composition of the Consortium is formed by GHERSA (51%) and NEXANT (49%). SENER is approaching the Consortium.
- Additional US participants are Boeing, Sandia and Tietronix.
- European participants GHERSA, Saint Gobain and CIEMAT applied for EC funds in March 2001. .
- Solar Tres is applying together with MECAVI and CIEMAT for Spanish funds and credits to the National call for R&D projects PROFIT.
- Plant definition is completed. Site selection still open. Preliminary design ending by December 2001.
- Consortium extending to new members.
- Beginning of engineering and construction depending on the date premium provisions come into effect.

Solar Tres: Project planning



Total budget: 84.1 million Euro (5,600 Euro/kW)

Solar Multiple = 3.8

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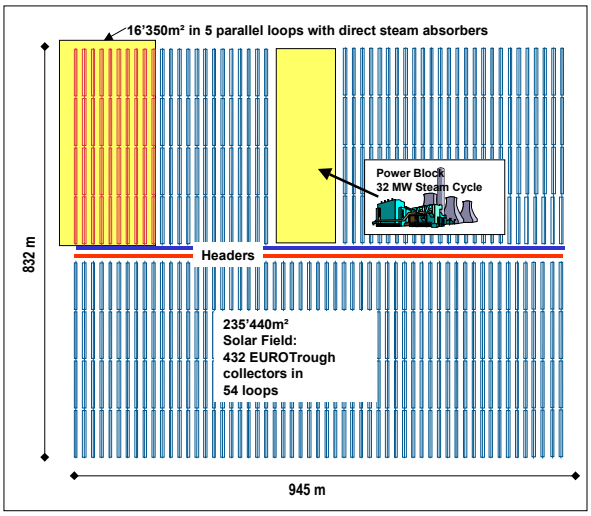
LucaSol 30/ LucaSol 50

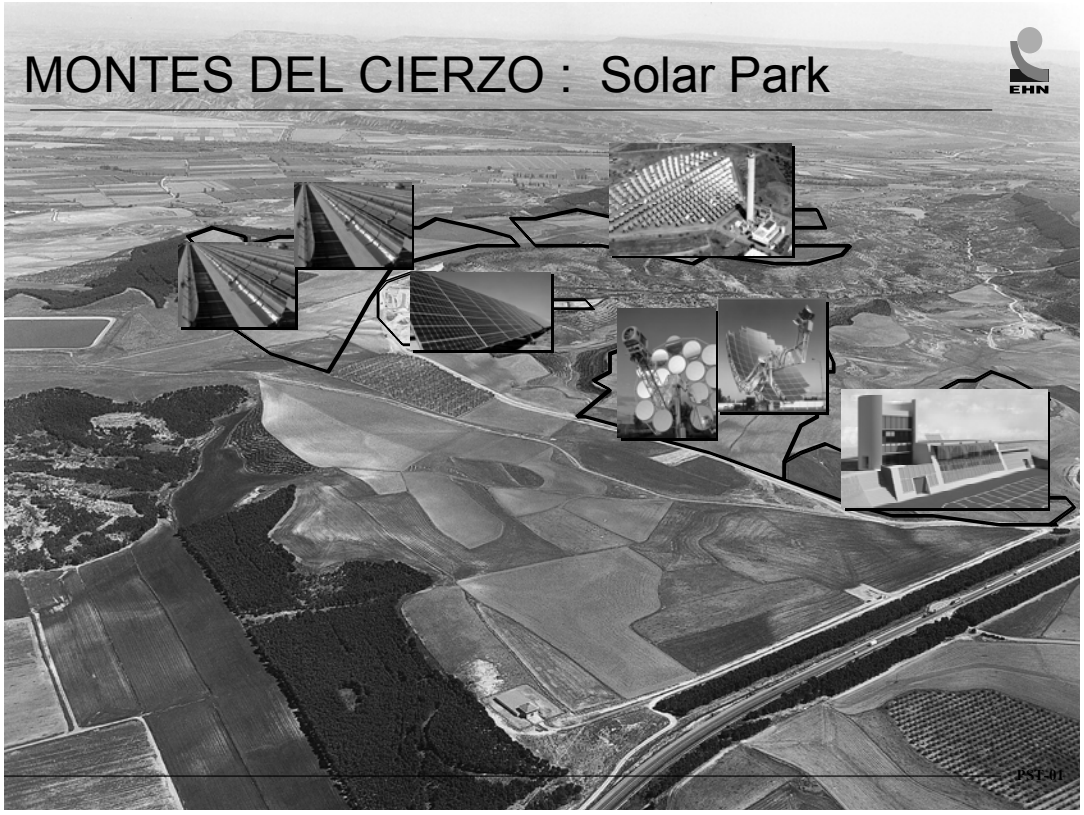
LucaSol is a 30-50-MW parabolic-trough solar power plants, based on SEGS experience and Eurotrough collector.

- LucaSol 50 cost is 130 million Euro (2,600 Euro/kW)
- LucaSol 50= 374'960 m² of solar collectors.
- LucaSol 30= 235'440 m² of solar collectors.



LucaSol 30/ LucaSol 50

- ☺ Two project sizes have been identified for the LucaSol project with 30 and 50 MW.
- ☺ Consortium LUCAINENA is promoting the project and it is formed by Gamesa and Solar Millennium. Iberdrola is participating.
- ☺ An EC project is being defined. Preliminary design is almost completed.
- ☺ Site selected: Lucainena de las Torres (close to Tabernas in Almeria).



MONTES DEL CIERZO : Solar Park

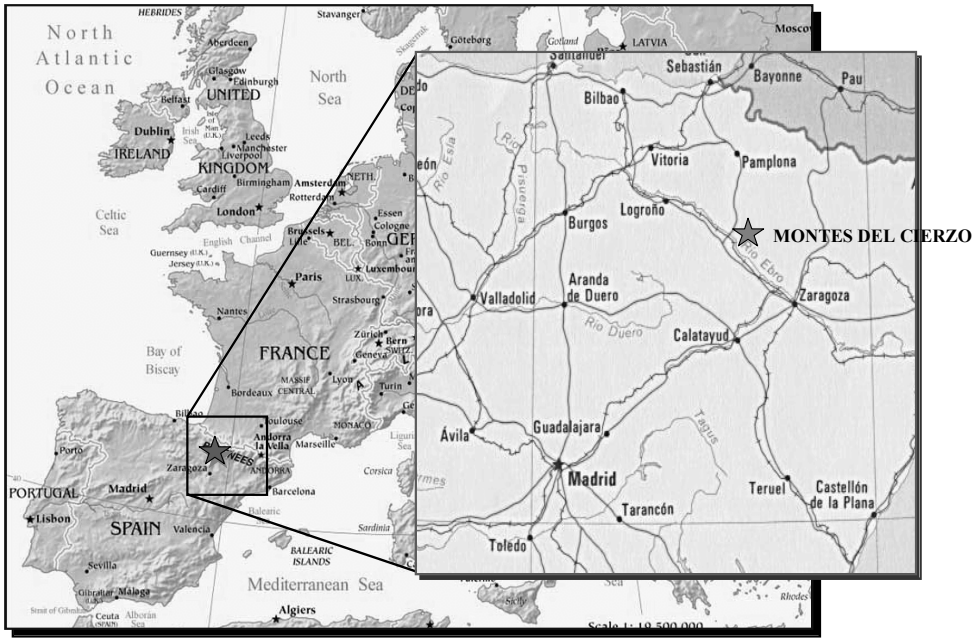
EHN

Park Objectives:

- Comprehensive Solar Technology Representation
- Industrial scale facilities
- Real situation evaluation
- Technology, Cost and Performance evaluation

PST-02

MONTES DEL CIERZO : Solar Park



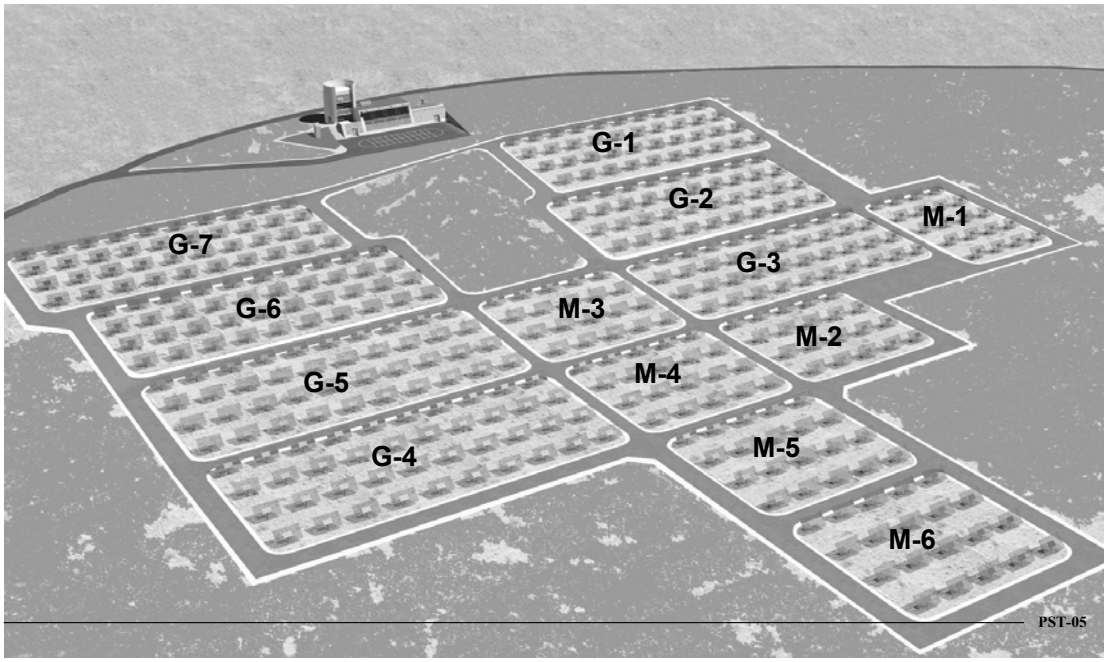
PST-03

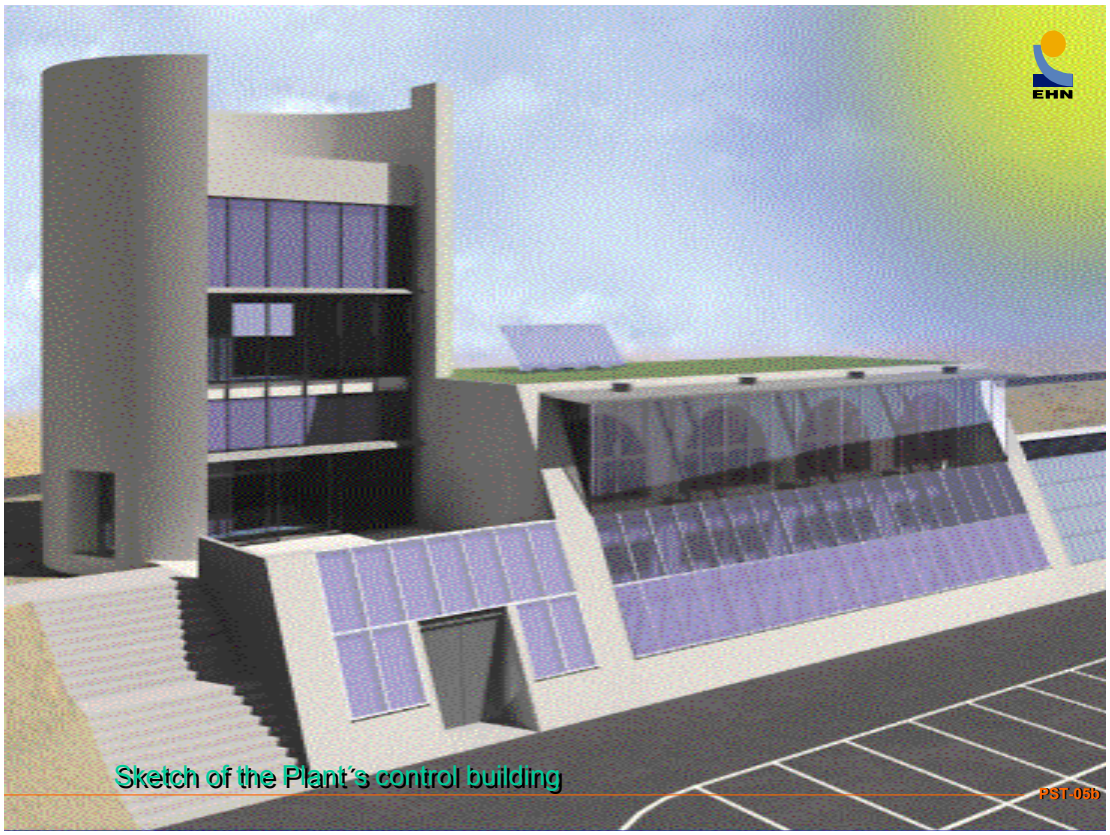
MONTES DEL CIERZO : Solar Park

- 21,5 MW Global electric Power
- 2.000.000 m^2 land surface
- Photovoltaic Technologies:
  - Flat Crystalline Si
  - Thin Film
  - Concentrating
- Solar Thermal Technologies:
  - Central Tower with Storage
  - Parabolic Trough
  - Dish Stirling

PST-04

MONTES DEL CIERZO : Photovoltaic Plant



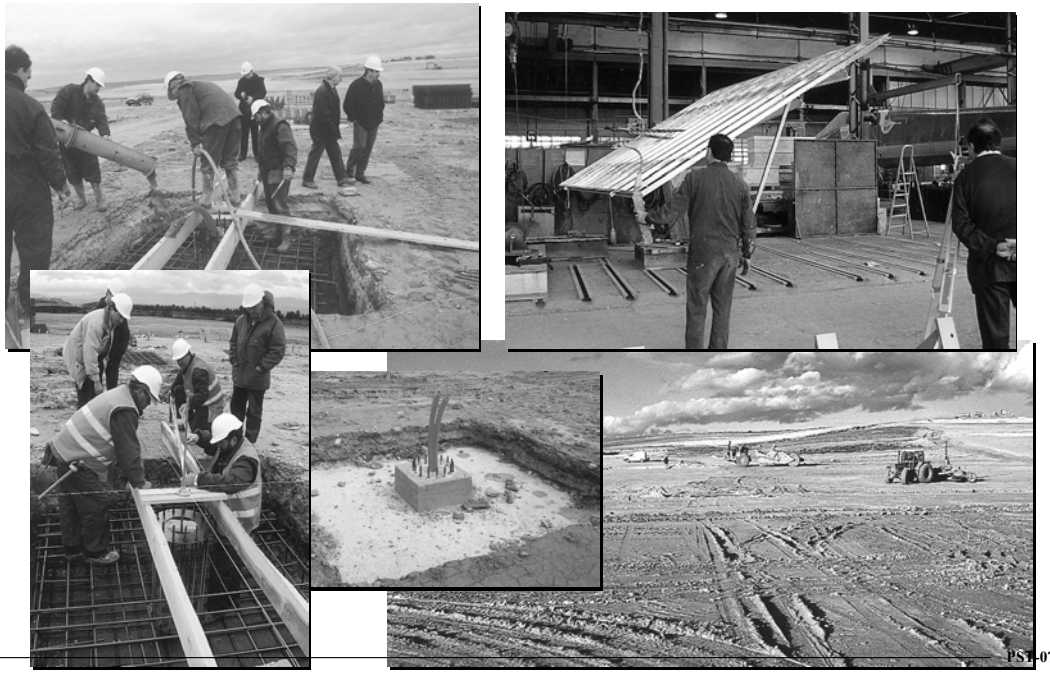


MONTES DEL CIERZO : Photovoltaic Plant

- 1.2 MW Crystalline Si technology,
- 400 Sun trackers distributed in 60.000 m^2
- 800 kWp configured as centralized area:
  - Connected to 7 x100 kWe Inverters
  - Remote Monitoring and Control System
- 400 kWp configured as Distributed Generation:
  - 2,5 & 5 kW Inverters
  - Individual Power units programming capability
  - Net metering capability on a 20 Power units “cluster”
  - Experimental area with “Thin film” and “AC” modules

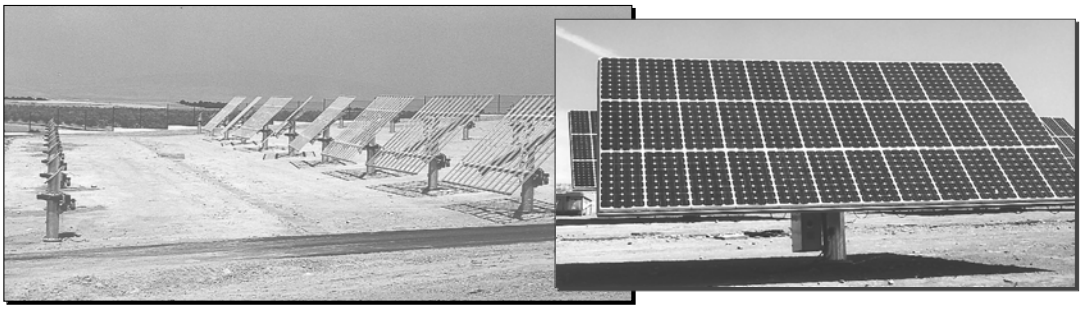
PST-06

MONTES DEL CIERZO : Photovoltaic Plant



PST-07

MONTES DEL CIERZO : Photovoltaic Plant



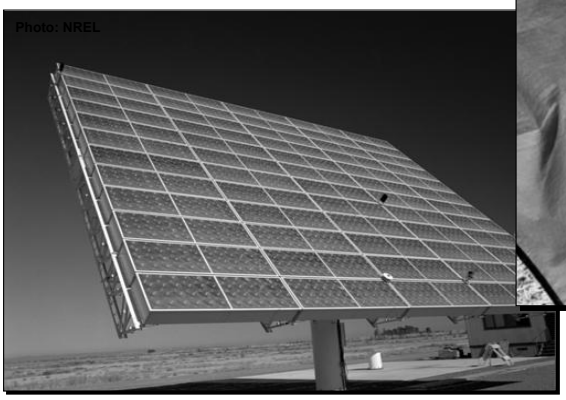
- Status on 2001-07-06
- Operation scheduled for oct-2001

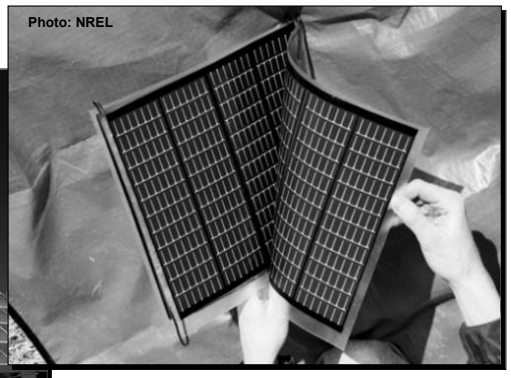
PST-08

MONTES DEL CIERZO : Photovoltaic Plant (II)

➔➔ Thin Film and Concentrating Technologies

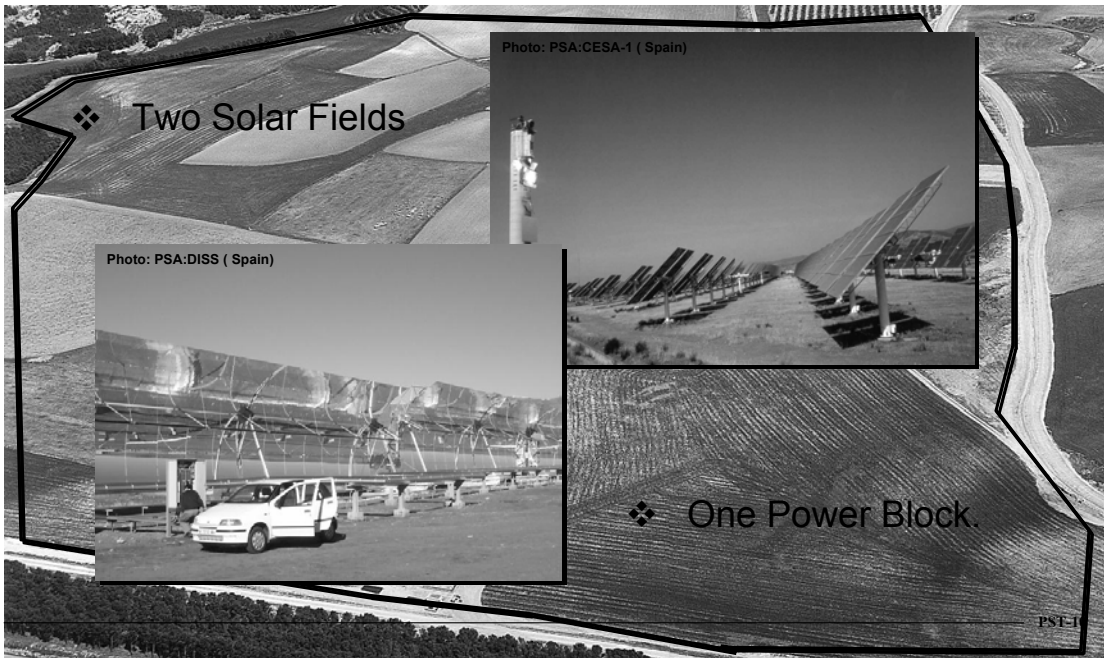
- 50 Sun trackers distributed in 70.000 m^2
- 0,1 MWp
- Project start scheduled for 2002





PST-09

MONTES DEL CIERZO : "Solar Thermal Plant



MONTES DEL CIERZO : 10 MW “Trough” Plant

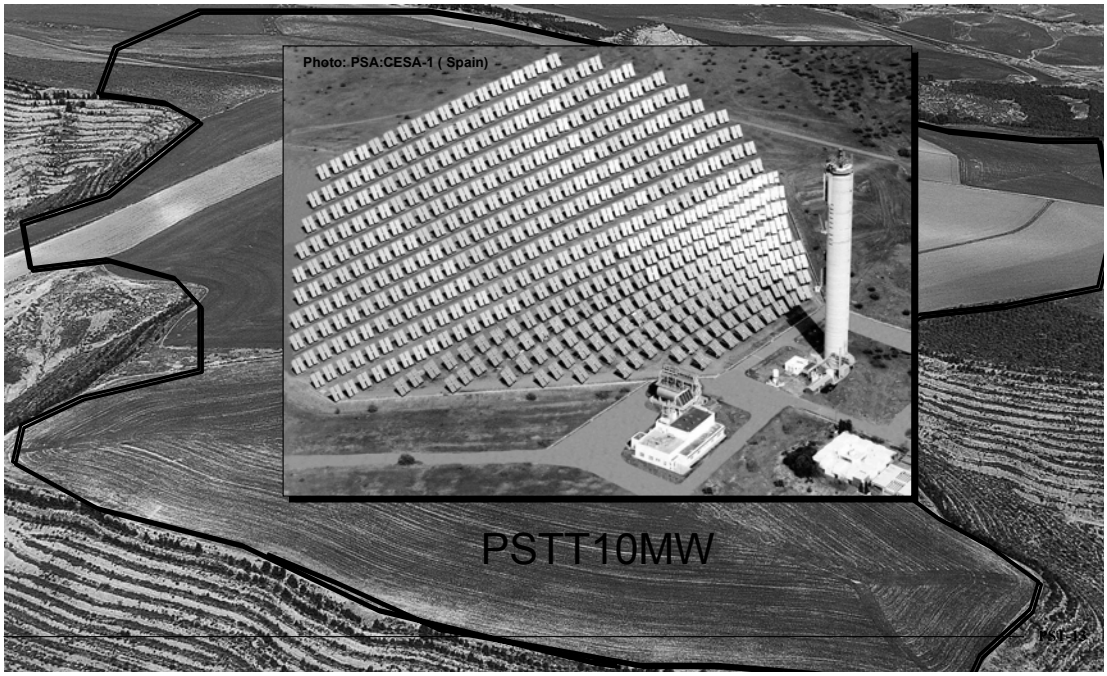
PST-11

MONTES DEL CIERZO : 10 MW “Trough” Plant

- 10 MW electric power
- 74.000 m^2 Solar Collectors : 135 LS-3 type units
- Thermal oil as HTF (SEGS technology)
- Conventional Power equipment Shared with “ Tower ” plant
- Annual expected production: 20.000 MWh
- Project start scheduled for beginning 2002

PST-12

MONTES DEL CIERZO : 10 MW “Tower” Plant

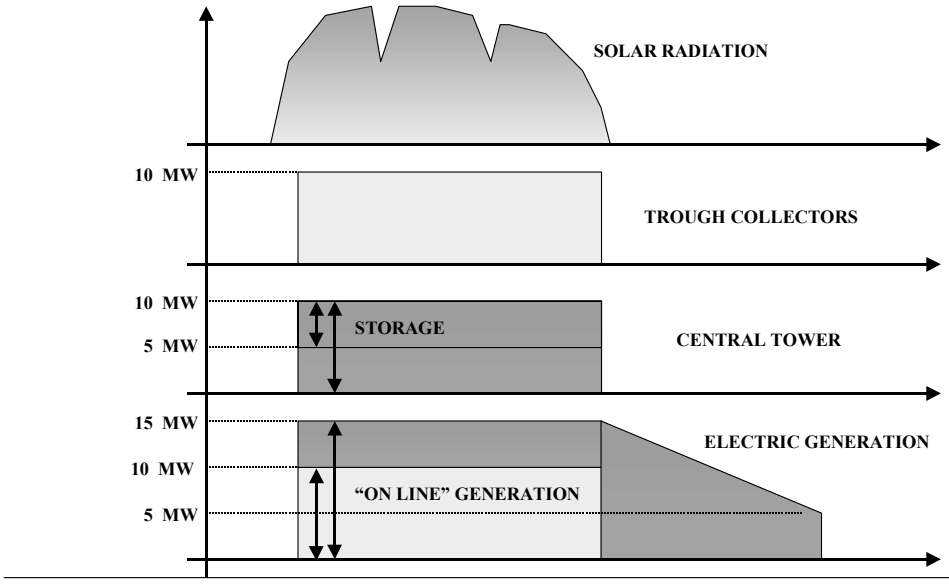


MONTES DEL CIERZO : 10 MW “Tower” Plant

- 10 MW electric power (5 + 5 MW)
- 5 hours thermal storage
- 74.000 m^2 heliostats : 930 units / 80 m^2
- Molten-salt technology (Solar two)
- Conventional Power equipment Shared with “Trough” plant
- Annual expected production: 16.500 MWh
- Project start scheduled for 2003

MONTES DEL CIERZO : "Solar Thermal Plant

Plant operation diagram:



PST-15

MONTES DEL CIERZO : "Solar Thermal Plant

Project Planning:

Tasks	2001	2002	2003	2004
Plant definition & Basic engineering				
Project final engineering				
"Trough" plant construction				
"Tower" plant construction				
Milestones		A	B	C D

Basic Project

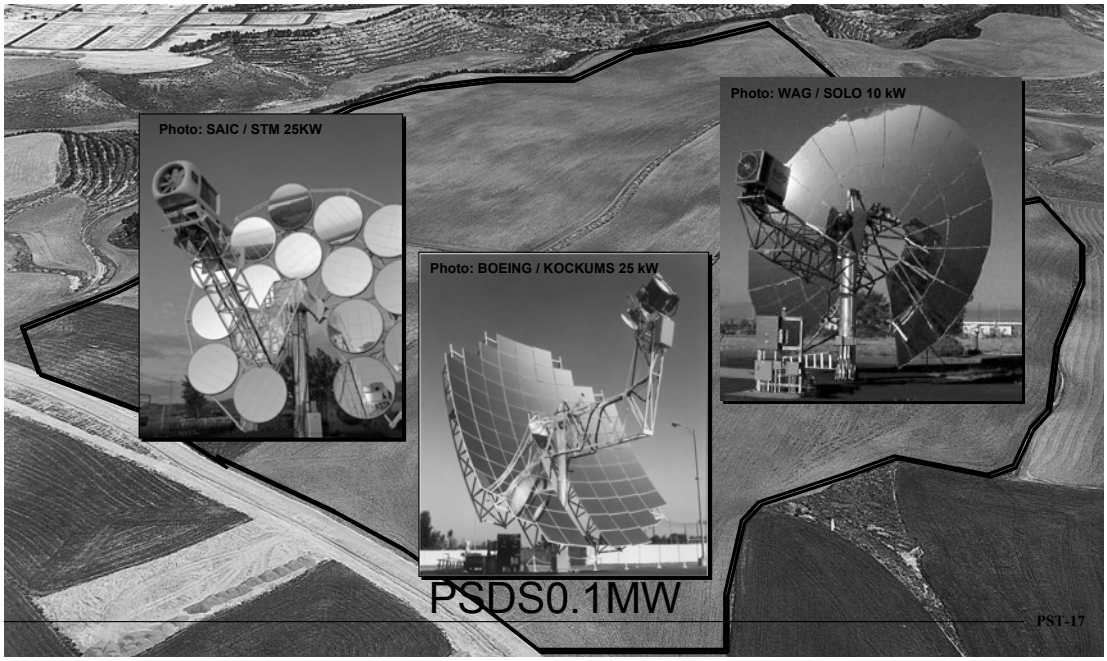
Project engineering & construction start

"Trough" plant operation

"Central Tower" plant operation

PST-16

MONTES DEL CIERZO : 120 kW "Stirling" Plant



PST-17

MONTES DEL CIERZO : 120 kW "Stirling" Plant

➔➔ Technology evaluation

- 6 Dish-Stirling units (2 +2 +2)
- 120 kW (50 kW + 50 k W + 20 kW)
- Three main technologies representation
- Annual expected production: 168 MWh
- Project start scheduled for half 2002

PST-18

MONTES DEL CIERZO : "Solar Thermal Plant

Project Participation

- Open possibilities : Solution provider, Technology provider, Engineering provider or project partner.
- Short Term collaboration: "Montes del Cierzo" Solar Plant
- Long Term collaboration: Solar Plants worldwide
- Key Issues:
  - Available Technology
  - Technology transfer terms & conditions

PST-19

EHN

A leading group in renewable energy sources

PST-20